Enabling Seamless Contextual Collaborations for Mobile Enterprises

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Motivation

In any enterprise:

- People communicate using different modalities, devices and services at different times
- People use multiple such communication mechanisms, simultaneously, to accomplish a task

As enterprise workers becoming increasingly mobile:

- Scenarios of anytime-anywhere collaboration, using different sets of devices, services and modalities at different times, arise
- One of the challenges is to enable seamless collaborations where people get an appropriate view of ongoing sessions at all times
Motivation (2)

To achieve this, the following need to be enabled:

- Best possible view of the session on the current set of devices, modalities and services, and user context
- Seamless adaptation of session upon any change in contextual parameters

Aspects to be considered:

- Media and services involved
- User’s current activity and preferences
- Available devices and their capabilities
- Available media and service transformation mechanisms
Main Contributions of this Paper

• Uses activity and activity-based preferences as the main drivers for determining appropriate transformations for multimedia sessions
  – Existing solutions primarily use device capability for determining most suitable transformations

• Provides a seamless mechanism for adapting multimedia sessions with user mobility
  – Many of the existing solutions adopt a suspend-resume mechanism for handling user mobility

• Addresses the complete problem of media adaptation and service adaptation for multiple media-service streams
  – Most existing solutions focus on media adaptation only
Collaboration Media, Services and Collaboration Context

Collaboration Media
– The *content* of a collaboration session, such as, text, audio, image, audio stream and image stream

Collaboration Services
– The *delivery mechanism* for the content, such as, IM, voice call, email etc.

Collaboration Context
– A set of *media-service pairs* constitute a collaboration session
Media-Service Transformations and Associated Cost

Types of Transformations

Service Transformation
Content remains the same but the delivery mechanism changes
E.g. Text-based IM → text delivered over email

Media Transformation
Content is transformed from one media-type to another but the delivery mechanism remains constant
E.g. Text file using file sharing service → Audio file using file sharing service

Media-Service Transformation
Both content and delivery mechanism are transformed
E.g. Voice call → Text-based IM

Cost of Transformation
Cost = aw₁ + βw₂, where w₁ = cost of media transformation
w₂ = cost of service transformation
a, β = relative costs of transformations
User Context – Activity and Preferences

A user’s context consists of two parts – preferences (which are static) and current activity (which is dynamic)

Activity

– We define activity in terms of location, group or individual activity, and free or busy status
  • When a user is attending a presentation
    activity = {office-conf-room, group, busy}
  • When he is in his office cabin
    activity = {office-cabin, individual, free}

– Current activity can be derived using a combination of location and calendar information

Preferences

– We define preferences in terms of activity, source media-service combination, and destination media-service combination

– Preferences are prioritized interactively by the system
  • Conflicts are detected by the system, and are resolved by the user at the time of definition
System Components

A user can define preferences using any device.

- Devices indicate their capabilities using CC/PP.
- Current set of user devices can be derived using a combination of presence and location information.

Allowed Media-Service Transformations Store

User Context Manager

Transformation Mappings Generator

Device Context Store

CCA Profiles

Preferences, Current activity

Collaboration Context

Collaboration System

Generates a set of media-service mappings, one for every input media-service stream.

Mappings are used by the media gateway to adapt the collaboration context.

Device Capabilities

Transformations, Cost

Original context

Adapted context

Media Gateway

System Components
Mechanism

1. Derive the set of possible transformations from the collaboration context and device context keeping (M,S) pair from each intact.

2. Filter out valid transformations using weighted allowed transformations table. Attach weights for valid transformations.

3. Filter out applicable preferences from prioritized user preferences table using current activity of user.

4. Choose an applicable transformation for each input media-service stream using prioritized applicable preferences and weighted valid transformations.

Device Context:

- D
- M
- S

Collaboration Context:

- M
- S

Allowed Transformations:

- M_{SRC}  S_{SRC}  M_{DEST}  S_{DEST}  Wt

User Context: Preferences:

- M_{SRC}  S_{SRC}  M_{DEST}  S_{DEST}  Wt

User Context: Current Activity:

- M_{SRC}  S_{SRC}  M_{DEST}  S_{DEST}

Mappings for session adaptation:

- D  M_{CC}  S_{CC}  M_{DC}  S_{DC}
Algorithm Performance Trends

Observations:

- Sensitivity of algorithm to inputs
  
  \[
  \text{input media-service streams} > \text{user preferences} > \text{user devices}
  \]

- For practical mobile collaboration scenarios\#, execution time is close to real-time

Algorithm execution time trends for a Java-based implementation on a PC (Pentium 4, Windows XP)

\# number of devices \(\leq 5\), number of preferences \(\leq 15\), number of input media-service streams \(\leq 5\)
Conclusions and Future Directions

Conclusions

– Activity and activity-based preferences are very important factors for determining appropriate transformation of multimedia sessions

– Using the mechanism discussed in this paper it is possible to achieve real-time adaptation for practical mobile collaboration scenarios

Future Directions

– Defining and capturing / modeling activity in a more precise way

– Addressing a larger space of user preferences so as to provide better adaptation

– Transformation cost analysis and developing practical cost models
THANK YOU!

Please send questions / comments to:

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Time Complexity Analysis

Terms used in the analysis
\[ L_P = \text{Number of applicable preferences} \]
\[ x = \text{No of initial user devices} \]
\[ y = \text{No of target user devices} \]
\[ i = \text{No of initial media-service streams} \]
\[ o = \text{No of target media-service streams} \]
\[ L_T = \text{No of allowed transformations} \]

Time Complexity of Problem Space
Determining applicable preferences
\[ = O(L_P) \]
Choosing most appropriate transformations
\[ = O(L_T C_y) \]
Total time complexity
\[ = O(L_P L_T) \]
(for practical cases no of transformations >> no of devices)

Time complexity of Solution
Determining possible transformations
\[ = O(i . y . o) = O(y^2) \quad ; \text{Size of table} = O(y^2) \]
Filtering out valid transformations
\[ = O(y^2 \log L_T) \quad ; \text{Size of table} = O(y^2) \]
Filtering out applicable user preferences from sorted preference table
\[ = O(L_P) \quad ; \text{Size of table} = O(L_P) \]
Choosing most appropriate transformations
\[ = O(L_P . y^2 \log(y^2)) \quad ; \text{Size of table} = i \]
Therefore, total time complexity of algorithm
\[ = O(L_P . y^2 \log(y^2)) \]